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The dangers of rationing dialysis treatment: The dilemma facing a developing country

MR Moosa[1] and M Kidd[2]

[1]Department of Medicine, Faculty of Health Sciences, University of Stellenbosch and Renal Unit, Tygerberg Academic Hospital, Cape Town, South Africa and [2]Centre for Statistical Consultation, University of Stellenbosch, Cape Town, South Africa

The increasing burden of chronic kidney disease places enormous strains on resources of all countries, but especially of those with emerging economies. Few developing countries are able to afford dialysis programs and those that do ration this scarce resource. In South Africa, rationing has been practiced since the introduction of dialysis. Our renal unit carefully screened patients with end-stage kidney disease (ESKD) based on certain medical and socioeconomic criteria. The outcome of these decisions taken by the Assessment Committee is reviewed in this study. Details of the 2442 patients with ESKD assessed between 1988 and 2003 for the renal replacement program were captured. Using univariate and multivariate analysis, the odds of being accepted for treatment based on several variables were determined. The majority (52.7%) of patients with ESKD were not offered renal replacement therapy in the period of study. The number of kidney transplants progressively decreased, as did the number of patients accepted. The patients mostly likely to be accepted for renal replacement therapy were aged 20–40 years, white, employed, married, non-diabetic, and lived in proximity to a dialysis center. Almost 60% of patients were denied renal replacement treatment because of social factors related to poverty. In a developing country, where rationing of treatment is unavoidable, it is difficult to ensure equity of treatment and certain groups are advantaged over others. In our experience, socioeconomic factors influenced decision to accept patients more profoundly than medical ones.

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Correspondence: *MR Moosa, Department of Medicine, Faculty of Health Sciences, University of Stellenbosch and Renal Unit, Tygerberg Academic Hospital, PO Box 19161, Tygerberg, Cape Town 7505, South Africa.*
E-mail: rmm@sun.ac.za

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Protagonists of renal medicine in developing countries face challenges completely different from those of their peers practicing in the West. The constraints on capital and human resources combined with a rapidly escalating chronic kidney disease burden places immense pressures on clinicians in developing countries who are forced to ration renal replacement treatment.[1,2] All the reasons for the rising incidence of chronic kidney disease are uncertain, but the increase in the global type II diabetes mellitus epidemic which is affecting developing countries more severely, with a commensurate increase in diabetic nephropathy is almost certainly one of them.[3–5] The other important risk factor for chronic kidney failure is possibly the ageing of the population. Even in developing countries, the population is rapidly aging as infectious diseases are brought under control[1] and the incidence of chronic kidney disease is higher in the elderly compared with the rest of the population.[6]

Worldwide, the prevalence of patients requiring maintenance dialysis treatment is increasing at an alarming 7% per annum.[7] The cost of treating these patients is set to escalate to an extent that will stretch the resources of even the wealthiest nations and it would not be surprising to see the return of some form of rationing in these countries. In the United States of America, there is a projected increase in spending to US$ 28 billion by 2010. More alarming is the prediction that by 2010 the number of patients with end-stage kidney failure will exceed two million globally and the aggregate cost of treatment for the millennium ending 2010 will exceed US$1 trillion.[7] Developing countries are predicted to shoulder a disproportionate share of this disease burden.[8] Compounding this is the AIDS pandemic that bites deeply into the health budget of countries in sub-Saharan Africa at the expense of other health priorities. In the West, rationing of dialysis was practiced 40 years ago when this new treatment modality was introduced. Rationing was the function of the so-called 'Life or Death Committees',[9] but the introduction of free or subsidized treatment in developed countries with almost universal entitlement allowed these committees to be dispensed with.[10] However, in developed countries rationing in renal replacement treatment continues to be practiced with the allocation of organs for transplantation. In this regard, it is clear that disparities exist that compromise those who are black, women, aged, and the poor.[11–14]

In developing countries where there is limited access to dialysis, some form of rationing has always been practiced.[15] Only a minority of patients with end-stage kidney disease (ESKD) in these countries enjoys access to renal replacement treatment; for the rest the diagnosis of chronic renal failure is a death sentence. Patients from middle-income countries such as South Africa have access, albeit limited, to renal replacement treatment. In 1997, the National Department of Health in South Africa drew up guidelines to formalize the selection process and assist nephrologists in the difficult task of patient selection. At most State institutions selection committees reminiscent of the 'Life or Death Committees' are responsible for making the final decision. At our institution, rationing has been the norm since the initiation of our renal replacement program in 1976 and draconian reductions in resources for chronic dialysis in the middle 1990s enforced further rationing. This is a report of the outcome of the decisions taken by the Assessment Committee operating at our institution. It highlights the tragic consequences of well intentioned but enforced actions and begs the rationality of these decisions.

RESULTS

The total number of patients assessed increased dramatically in 1990 and since then has maintained a high cyclical trend, whereas the number of patients accepted has been decreasing (Figure 1). Over the same period, the number of kidney transplants performed annually has decreased dramatically (Figure 2). Of the 2442 patients assessed over the 15-year period of the study, 1155 (47%) were accepted for renal replacement treatment and 1287 (53%) were treated conservatively. Of the patients refused treatment, 743 (59%) were denied primarily owing to social factors (Figure 3). These social factors were associated with poverty, and included living circumstances that were unsuitable for continuous ambulatory dialysis, unemployment, lack of insight into illness, lack of education/illiteracy, criminal record, poor compliance, substance abuse, traveling difficulties. In many cases, a combination of social circumstances and medical factors mitigated against a patient's acceptance for treatment.

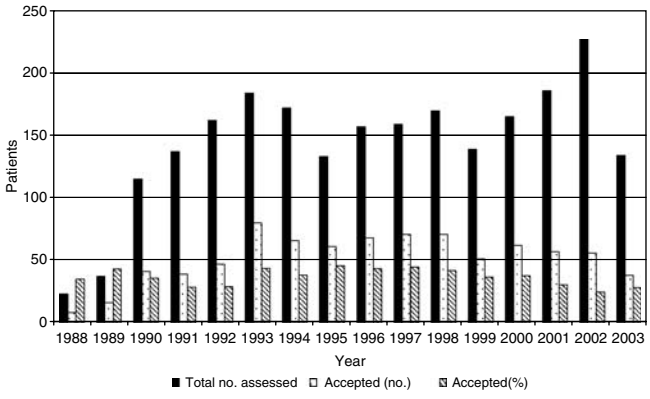

Figure 1 | Outcome of assessments of patients with advanced chronic kidney disease.

Details of the patients are shown in Table 1. The patients accepted for treatment were significantly younger than the patients treated conservatively. Only 17 (1.3%) patients 60 years and older were accepted, although this age group comprised 221 (17%) of the patients treated conservatively ($P<0.001$). More white patients were accepted compared to non-white (black and colored) patients ($P<0.001$). Chronic glomerulonephritis accounted for 41% of all-cause ESKD. Diabetes mellitus and hypertension accounted for 15.8% and 15.1% of all primary causes of ESKD, respectively. The etiology of ESKD in the two groups was comparable except for the disproportionate number of diabetics ((305 (25%)

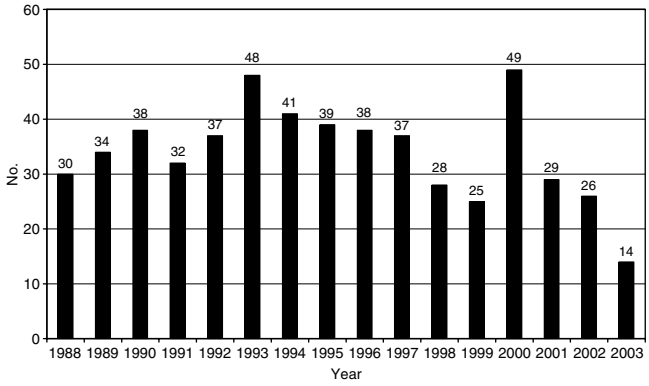

Figure 2 | The number of kidney transplants performed from 1988 to 2003.

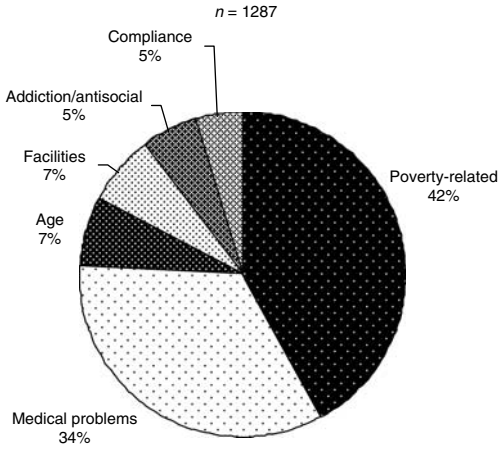

Figure 3 | Primary reasons for the non-acceptance of patients for renal replacement treatment. The majority of patients with ESKD fail to qualify for treatment for poverty-related problems such illiteracy, lack of funds to travel to the treatment center, and poor record of compliance. The main medical problem was the presence of cardiovascular disease. Although the presence of HIV/AIDS is a problem in sub-Saharan Africa, only 16 patients were HIV positive and refused treatment in the last 5 years. This could be because many patients with HIV infection died of other complications before they develop HIV-associated nephropathy. Alternatively, these patients were not referred because our policy of not accepting these patients for renal replacement treatment was well known by our referring structures.

compared to 70 (6%), $P<0.01$)) in the group treated conservatively (Figure 4). The odds of being accepted for treatment were calculated for a number of variables and are shown in Tables 2 and 3. Patients aged between 20 and 40 years were the most likely to be accepted and those over 60 years the least. Of greater concern was that white patients were almost four times more likely to be accepted for treatment than non-white patients. There was no gender difference in the chances of receiving treatment. Patients who contributed to society by being employed and who were therefore making a contribution to the economy were also favored. Both marital status and parenthood played important roles in the selection of the patients.

Owing to the exploratory nature of the classification and regression tree analysis, a randomly selected hold-out sample (30% of the data) was used to verify the results. Three major variables namely employment, age, and race was identified as influencing the acceptance rates. The acceptance was low (16%) in unemployed patients regardless of age and race. Employed patients aged <50 years enjoyed the highest acceptance rate (79%). Patients, who were non-white, employed, and older than 50 years had low acceptance rates (11%) compared to white employed patients over 50 years who had acceptance rates of 67%.

Table 1 | Comparison of demographic details of 2442 ESKD patients assessed for renal replacement treatment.

	Rejected *n*=1287 (52.7%)	Accepted *n*=1155 (47.2%)	*P*-value
Mean age (CI)	47.0 (46.3–47.8)	36.6 (37.0–38.3)	<0.01
Sex			0.7
Male (%)	669 (52.0)	591 (51.2)	
Female (%)	618 (48.0)	564 (48.8)	
Race			<0.01[a]
Black (%)	133 (10.3)	141 (12.2)	
Colored (%)	953 (74.0)	691 (59.8)	
White (%)	201 (15.6)	323 (28.0)	

CI, 95% confidence interval; ESKD, end-stage kidney disease.
[a]White versus non-white (colored and black) patients.

DISCUSSION

The need to ration expensive medical services is a reality in most developing countries. Our data show that over the past decade the number of patients accepted has been steadily decreasing both in absolute as well as relative terms. The reasons for this are twofold. The primary reason is the constraints placed on health budgets by local health authorities, which are mainly responsible for health funding in the public sector, which serves the majority of South African population. In 1997, the funding of our dialysis unit was capped to allow treatment of 80 patients with ESKD and has remained unchanged since. The second is the declining transplant rate, which has been experienced nationally as well internationally and the reasons for which remain speculative.[17] In 2002, the non-acceptance rate peaked at 69.6%. For the decade 1993–2003, the acceptance rate for renal replacement treatment at our institution has been falling on average 1.5% per annum, whereas the growth of the Western Cape population annually averaged 2.9% between 1996 and 2001 (Statistics South Africa, 2001, Pretoria, Report 03-02-13). The declining treatment rate in our unit contrasts sharply with the steadily rising incidence of renal replacement in developed countries.[18] The rates have varied between countries but have been as high as 11% in Japan[19] and averaging between 3 and 4.3% in Europe. In the latter, the elderly benefited the most with the greatest increase in dialysis rate being in patients aged over 75 years and contrasts sharply with our own experience where very few patients over 60 years receive treatment.[18]

The average annual cost of renal replacement therapy per patient far exceeds the gross domestic income per capita of most of developing countries.[15] In South Africa, the gross domestic product per capita was US$3480 in 2004. In the same year, the annual cost of hemodialysis for a single patient

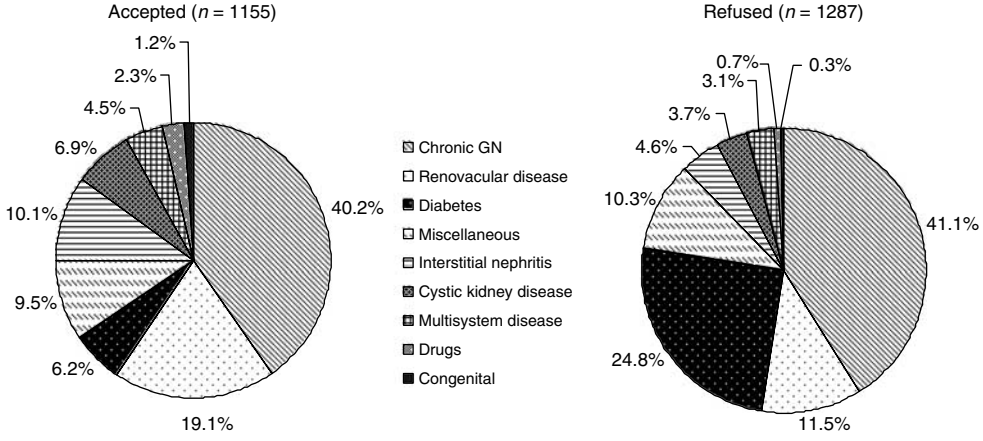

Figure 4 | Etiology of chronic renal failure in two groups of patients based on the outcome of assessment for renal replacement treatment. The main difference between the two groups was that fewer patients with diabetes were accepted for treatment. GN, glomerulonephritis.

Table 2 | Univariate analysis of ESKD patients selected for treatment

Variable	Level	N	Accepted (%)[a]	P-value	Odds ratio	95% CI	
Renal disease	Diabetic	416	20				
	Non-diabetic	1998	57	<0.01	5.14	4.06	6.52
Age	<20 years	119	62				
	20–40 years	1135	67				
	41–60 years	885	39				
	>60 years	235	7	<0.01	—		
Race	Colored	1633	44				
	Whites	540	75				
	Blacks	241	43	<0.01			
Gender	Male	1206	50				
	Female	1208	51	0.54	1.05	0.90	1.23
Marital status	Never married	515	34				
	Ever Married	1239	38	0.07	1.22	0.98	1.51
Dependents	Yes	900	55				
	No	1370	48	<0.01	1.32	1.12	1.57
Region	Metropole	1608	51				
Distance from dialysis center (km)	51–100	297	51				
	101–200	254	39				
	>200	122	45	<0.01	—		
Employment	Unemployed	733	7				
	Employed	924	55	<0.01	17.13	13.07	22.44

CI, 95% confidence interval; ESKD, end-stage kidney disease.
[a]Note that percentages will not necessarily add up to 100% because the percentage accepted patients is for different groups.

Table 3 | Results of the best subsets logistics regression analysis

Variable	Odds ratio	95% CI		P-value
Age	0.91[a]	0.89	0.93	<0.01
White race	3.87	2.3	6.50	<0.01
Married	5.99	3.12	11.51	<0.01
Employed	5.42	3.12	9.39	<0.01

CI, 95% confidence interval; ESKD, end-stage kidney disease.
[a]This is the odds ratio for 1 year intervals. For 10-year-intervals it is 0.38 (95% CI: 0.30–0.47).

Table 4 | Factors limiting provision of renal replacement services in poor countries

1	Lack of financial resources
2	Lack of human resources
3	Rural location of population
4	Other health priorities
5	Lack of governmental will
6	HIV/AIDS in sub-Saharan Africa
7	Lack of basic amenities
8	Inaccessibility/lack of cheap transport
9	Late diagnosis of chronic kidney disease
10	Poor nutrition

HIV, human immunodeficiency virus.
Adapted from Chugh and Jha.[21]

in our unit was US$9130, whereas continuous ambulatory peritoneal dialysis (CAPD) cost US$8319 (unpublished data). The cost of dialysis is therefore prohibitive and the majority of patients, even if reasonably affluent, would find dialysis a major financial hardship. Of all the patients in South Africa, 82% rely on the State for health funding and 18% on privately funded medical schemes that contribute significantly to the cost of dialysis treatment.[20] The other problems of the provision of renal services to a large population are common to most developing countries (Table 4).[21] In a country where infectious diseases such as tuberculosis and AIDS continue to take a massive human toll, access to basic health care, improvements in nutrition, and access to basic facilities such as running water, sanitation, and electricity are a priority, renal replacement therapy unfortunately does not yet enjoy much support from health authorities.

It is well known that minority groupings are less likely to access certain forms of medical interventions. There are gender-based disparities in accessing cancer-screening tests, cardiovascular procedures, and medications for human immunodeficiency virus (HIV).[12] The race-based differences in accessing treatment or interventions are even better known[22–24] and include access to renal replacement therapy.[25] In our unit, patients were selected using criteria that took into consideration both psychosocial and medical factors, but with the former influencing decision making more than the latter. The criteria were later formalized by the National Department of Health.[26] The single most important criterion determining selection was suitability for kidney transplanta-

tion. If patients were unable to receive organs they were summarily denied dialysis treatment. The medical reasons that excluded patients from treatment included advanced disease of other vital organ systems, advanced malignancies, or severe psychiatric disease. The second important consideration was the ability of patients to access treatment facilities. The unit serves a large agricultural community in towns and villages situated vast distances from the main dialysis treatment center. The population serviced was largely indigent with lack of adequate access to basic facilities such as potable water and electricity. CAPD was often considered and used in certain situations, although the household setup for CAPD was unsatisfactory in most cases. Due consideration was given to how patients started on CAPD would be managed should the technique fail. Finally, the treatment was preferably offered to those patients who the Assessment Committee felt would derive the greatest overall benefit. Unemployed patients were deemed to place an additional burden on a social welfare system already struggling to meet the needs of its citizens; selection thus favored the employed and those who were responsible for the care and support of dependants. Younger patients were also, arguably, favored because it was felt that they were likely to derive greater benefit than the elderly who also were more likely to have co-morbid diseases. As dialysis was performed mainly in urban areas, patients in rural settings (who comprised about one half of the population) were disadvantaged. One way of overcoming this problem is to decentralize dialysis to nodal units that can service several surrounding villages and towns. In the United Kingdom, almost 40% of patients receive their treatment in satellite units. It has been shown that these units can service a large part of the dialysis population and can be effectively operated by nursing staff alone without an onsite nephrologist.[27]

The declining number of transplants being performed is of great concern, but is part of a countrywide and international trend, and its relation to the increasing difficulty to enter the renal replacement program is coincidental. Because of the high incidence of end-stage kidney failure in our population, all available 'slots' for dialysis are readily filled with deserving patients and to ensure turnover kidney transplantation is crucial. Without an active transplant program, the dialysis program would be doomed to stagnation. Innovative ways of enhancing kidney transplantation need to be investigated.[17]

An important factor, which is difficult to quantify (but often taken into consideration by the Committee) and limiting the provision of renal replacement treatment in developing countries is the lack of skilled personnel to care for patients (Figure 5). South Africa has a well-developed health structure quite capable of training medical and paramedical staff, but lack of adequate career pathing, poor salaries, and lack of a structured health plan has resulted in severe disillusionment among South African health professionals in the public sector, who leave for private sector employment or, more commonly, for countries such as Canada, United States of America, and the United Kingdom as well as the Middle-Eastern countries where they are in great demand.[28,29] All areas of health including the care of renal patients suffer as a result. Anecdotally, the situation arises not infrequently where capital resources are available but the lack of trained staff prevent expansion of the renal replacement program. Reversing this 'brain-drain' remains a major challenge for the heath authorities.

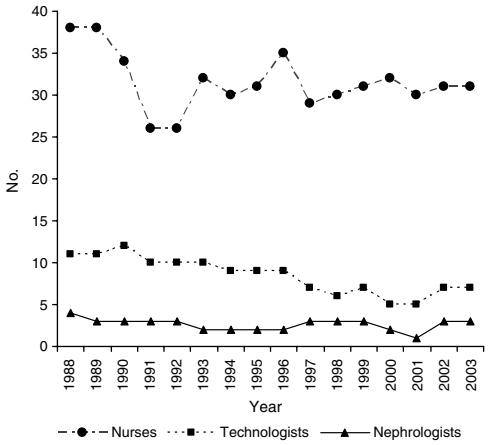

Figure 5 | Human resources. There was a decline in all levels of renal personnel. What is not reflected here is the high personnel turnover. In the study period, for example, seven nephrologists left the service for the private sector or work abroad, and they were replaced by younger less experienced specialists. Similarly, among nurses the turnover was even greater with the depletion of skilled health-care staff. There was a progressive decline in the number of technologists mainly as a result of attrition. For most of the 1990s, there was a moratorium on the filling of posts and when this was lifted posts could not be filled except by trainees because of a national shortage of skilled dialysis staff, both technical and nursing.

With the basic criteria to guide the Assessment Committee, it is interesting to note the outcome of these deliberations. Although every effort was made to ensure equity in the allocation of renal services, it is clear that white patients were much more likely to be treated than other race groups. This implies that white patients were more likely to satisfy the suggested guidelines than non-white patients. White patients were more likely to live closer to dialysis centers, and be employed than non-whites as a result of the privileged status of these patients under the previous political dispensation, which continues to exert an influence on life in South Africa. The other important determinant of acceptance was the age of the patient. Very few patients over the age of 60 years were treated, the assumption being that the risk of complications and mortality increase with age (as would costs), but more importantly perhaps, that younger patients would be able to benefit more and for longer than older patients following kidney transplantation. This approach to the elderly is very debatable and probably unfairly discriminates against a very vulnerable group in the society.[30,31] Mallick and de Caestecker[32] eloquently argue that the younger patient starting dialysis at 30 years and surviving for 30 years will consume more resources than an elderly patient allowed three or four additional years to enjoy with his family. Less

than 16% of patients in this cohort were diabetic and only 18.6% of diabetic patients who were assessed were accepted for renal replacement treatment. The reluctance to accept diabetic patients was based on observations that diabetic patients had a worse outcome both on dialysis and transplantation. These patients were more likely to have and develop complications, and as such were more costly to maintain on treatment. Although the experience in developed countries has shown improved survival, this remains to be shown for those in developing countries.[33] Married patients and those employed were also favored. This reflects the principle that favors patients with dependants and those making an economic contribution to society. Although we showed no gender differences in the treatment of patients with kidney failure, in many developing countries female patients make up a much smaller proportion of ESKD patients treated. This is almost certainly the result of social and cultural factors that favor the treatment of men.[15,34]

The acceptance rate for renal replacement therapy varies in different regions of developing countries with a clear relationship to the wealth of individual nations.[2,35,36] This is illustrated by the remarkable growth of dialysis facilities with the burgeoning economies of the previous Soviet bloc countries.[37] On the Indian sub-continent, only 3–5% of all patients with ESKD receive any form of renal replacement. Of those who start hemodialysis, some 60% are lost to follow-up within 3 months as the economic realities of the treatment come into play.[38] Whereas screening of ESKD patients is practiced throughout the public sector hospitals in South Africa, it is less clear how other emerging countries decide on whom to accept for treatment.[2,39] In many countries, patients are often only offered acute treatment for a limited period of time, during which time they need to produce a living kidney donor or are required to fund ongoing dialysis from own sources.[40–42]

It is clear from this investigation that the process of selection of patients for renal replacement treatment, even with the best intentions, is severely flawed and leads to inequity in service delivery. The most adversely affected are the poor (represented in this study by non-white patients) and the elderly. A similar problem was faced in USA before the Medicare was extended to all patients with ESKD and social factors were taken into consideration. As in this study, selection for the dialysis program favored the young, white, male, and the employed patients.[43] Current reports show that where doctors' discretion is required in waitlisting white, male, young high income patients are more likely to receive cadaveric transplants.[14,44–47] The problem can be improved by empowering and uplifting the poor that will have the effect of reducing certain forms of renal disease and allowing greater access to treatment options. With its vast and growing population, South Africa faces a major challenge. Indicators are that the economy should grow at the rate of 3–5% per annum, but it has been predicted that by 2010, the AIDS epidemic could cost South Africa as much as 17% in gross domestic product growth. Investment in other chronic diseases is therefore unlikely to be a priority, but every effort should be made on behalf of society to overcome the prejudice against renal patients. The prevalence of chronic kidney disease is rapidly rising worldwide at an estimated 8% annually[48] and it is likely that developing countries such as South Africa are even more vulnerable. Early intervention of chronic kidney disease and the correct management of diabetes mellitus and hypertension may stem the tide.[13] Health authorities need to realize that chronic kidney disease is as much a social, economic, and ethical problem, as it is a medical one.[49] Unless there is a concerted effort by governmental health agencies together with medical authorities to address the problem the consequences are likely to be dire.

MATERIALS AND METHODS

Since the inception of the renal replacement program some 30 years ago, records have been kept at our institution of the decisions made by the Assessment Committee responsible for assessing the suitability of patients with ESKD for renal replacement treatment. Our center offers chronic dialysis (hemodialysis and CAPD) as well as kidney transplantation. The center is situated in the metropolis of Cape Town with three satellite hemodialysis units all approximately 100 km from the main center serving some of the rural population.

The main treatment center is situated at a teaching hospital that serves approximately one-half of the four million (census 2004) population of the Western Cape region of South Africa. The dialysis program was initiated in 1976, but for the purposes of this study we limited ourselves to reviewing the data between 1988 and 2003 when information was reliably computerized. The Assessment Committee consisted of the attending nephrologists, responsible physician, social worker, renal nursing staff, and renal technologists; at least one representative of each category of health-care worker was present at each meeting, which was held weekly. Hospital administrators had a standing invitation, whereas attempts to involve lay persons were unsuccessful. The committee was appointed by the head of the health institution according to the guidelines from the National Department of Health and reported to the hospital authorities. Psychological evaluations of patients were requested from time to time. Decisions to accept patients for renal replacement treatment were generally based on medical criteria (transplantability being the main one) and social criteria (employment, housing status, marital status, dependants, and distance from a treatment center). Difficult to document but also considered at assessment was the availability of resources (both human and capital) for dialysis at the time of evaluation. All patients were included in the analysis; referring physicians were encouraged to present all ESKD patients, even patients such as the elderly and those with advanced AIDS who were unlikely to be offered renal replacement treatment, for assessment, and to let the committee make the final decision.

Over the 15-year period of the study, 2442 patients were assessed, of whom 48.3% were female. The mean age of the patients was 42.6 years (95% confidence interval:42.1–43.2). The main reason(s) for refusing treatment was noted. The effect of variables on the odds of being accepted for the program was statistically analyzed. Three separate analyses were performed. Firstly, the effect of each of the variables on its own was investigated by cross-tabulations and calculating the χ^2 test to determine significant dependencies

(univariate analysis). Where applicable, odds ratios were also calculated. The variables that were chosen included demographic factors, marital status, dependants, employment status, distance from the treatment center, and primary renal disease. Secondly, to determine the combined effect of the variables on acceptance for treatment, a best subsets logistic regression was performed. The purpose of this method was to determine the optimal subset of variables that had the best predictive power for acceptance. Thirdly, classification and regression tree analysis was used to determine which variables are important in determining acceptance. The advantage of this method is that it can handle combinations of categorical and continuous variables, and it has the ability to derive rules from the data, which gives more insight into the data. Classification and regression tree splits a continuous variable into two classes and defines two subspaces that maximize overall class separation. These subspaces each then serves as basis for further partitioning independently of the others. At each step, the variable used for each split is selected from all the predictor variables so as to provide an optimal partition given the previous actions.[16] All values are means and 95% confidence intervals. Continuous data were analyzed using Student's *t*-test and categorical data χ^2 test. These tests were performed on an IBM compatible computer, using Statistica for Windows version 7.0. (Statsoft Inc., 2004, Tulsa, OK, USA). Significance was set at the 5% level. This study was approved by the Committee for Human Research of the University of Stellenbosch.

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REFERENCES

1. El Nahas AM, Bello AK. Chronic kidney disease: the global challenge. *Lancet* 2005; **365**: 331–340.
2. Barsoum RS. Chronic kidney disease in the developing world. *N Engl J Med* 2006; **354**: 997–999.
3. Wild S, Roglic G, Green A *et al.* Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care* 2004; **27**: 1047–1053.
4. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. *Diabetes Care* 1998; **21**: 1414–1431.
5. Amos AF, McCarty DJ, Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. *Diabet Med* 1997; **14**(Suppl 5): S1–85.
6. USRDS. The United States Renal Data System. *Am J Kidney Dis* 2003; **42**(Suppl 5): 1–230.
7. Lysaght MJ. Maintenance dialysis population dynamics: current trends and long-term implications. *J Am Soc Nephrol* 2002; **13**(Suppl 1): S37–S40.
8. Atkins RC. The changing patterns of chronic kidney disease: the need to develop strategies for prevention relevant to different regions and countries. *Kidney Int* 2005; **68**(Suppl 98): S83–S85.
9. Alexander S. They decide who lives, who dies. *Life* 1962; **9**: 103–125.
10. Rettig RA. The social contract and the treatment of permanent kidney failure. *JAMA* 1996; **275**: 1123–1126.
11. Furth SL, Garg PP, Neu AM *et al.* Racial differences in access to the kidney transplant waiting list for children and adolescents with end-stage renal disease. *Pediatrics* 2000; **106**: 756–761.
12. Garg PP, Furth SL, Fivush BA, Powe NR. Impact of gender on access to the renal transplant waiting list for pediatric and adult patients. *J Am Soc Nephrol* 2000; **11**: 958–964.
13. Bello AK, Nwankwo E, El Nahas AM. Prevention of chronic kidney disease: a global challenge. *Kidney Int* 2005; **68**(Suppl. 98): S11–S17.
14. Kjellstrand CM. Age, sex, and race inequality in renal transplantation. *Arch Intern Med* 1988; **148**: 1305–1309.
15. Moosa MR, Walele AA, Daar AS. Renal transplantation in developing countries. In: Morris PJ (eds). *Kidney Transplantation: Principles and Practice*. WB Saunders: Philadelphia, 2001 pp. 659–692.
16. Gaudart J, Poudiougou B, Ranque S, Doumbo O. Oblique decision trees for spatial pattern detection: optimal algorithm and application to malaria risk. *BMC Med Res Methodol* 2005; **5**: 22.
17. Buckley TA. The shortage of solid organs for transplantation in Hong Kong: part of a worldwide problem. *Hong Kong Med J* 2000; **6**: 399–408.
18. Stengel B, Billon S, Van Dijk PC *et al.* Trends in the incidence of renal replacement therapy for end-stage renal disease in Europe, 1990–1999. *Nephrol Dial Transplant* 2003; **18**: 1824–1833.
19. Usami T, Koyama K, Takeuchi O *et al.* Regional variations in the incidence of end-stage renal failure in Japan. *JAMA* 2000; **284**: 2622–2624.
20. Goudge J. *The Public-Private Mix. South African Health Review*. SA Health Systems Trust: Durban, 1999: 69–82.
21. Chugh KS, Jha V. Differences in the care of ESRD patients worldwide: required resources and future outlook. *Kidney Int* 1995; **48**(Suppl 50): S7–13.
22. Whittle J, Conigliaro J, Good CB, Lofgren RP. Racial differences in the use of invasive cardiovascular procedures in the Department of Veterans Affairs medical system. *N Engl J Med* 1993; **329**: 621–627.
23. Goldberg KC, Hartz AJ, Jacobsen SJ *et al.* Racial and community factors influencing coronary artery bypass graft surgery rates for all 1986 Medicare patients. *JAMA* 1992; **267**: 1473–1477.
24. Schulman KA, Berlin JA, Harless W *et al.* The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med* 1999; **340**: 618–626.
25. Barker-Cummings C, McClellan W, Soucie JM, Krisher J. Ethnic differences in the use of peritoneal dialysis as initial treatment for end-stage renal disease. *JAMA* 1995; **274**: 1858–1862.
26. Naicker S. End-stage renal disease in sub-Saharan and South Africa. *Kidney Int* 2003; **63**(Suppl 83): S119–S122.
27. Feest TG, Rajamahesh J, Byrne C *et al.* Trends in adult renal replacement therapy in the UK: 1982–2002. *Quart J Med* 2005; **98**: 21–28.
28. Editorial. Migration of health workers: an unmanaged crisis. *Lancet* 2005; **365**: 1825.
29. Eastwood JB, Conroy RE, Naicker S *et al.* Loss of health professionals from sub-Saharan Africa: the pivotal role of the UK. *Lancet* 2005; **365**: 1893–1900.
30. Gotloib L. Moneytheism and the crime of being old. *Nephron* 2000; **85**: 191–193.
31. Berlyne GM. Medical concerns and the national budget allocations. *Nephron* 1995; **71**: 125–126.
32. Mallick NP, de Caestecker MP. The changing population on renal replacement therapy: its clinical and economic impact in Europe. *Nephrol Dial Transplant* 1996; **11**(Suppl 2): S2–S5.
33. Breyer J. Diabetic nephropathy. In: Greenberg A, Cheung AK, Coffman TM, *et al.* (eds). *Primer on Kidney Diseases*. Academic Press: San Diego, CA, 1998, pp 215–220.
34. Barsoum RS. Overview: end-stage renal disease in the developing world. *Artif Organs* 2002; **26**: 737–746.
35. Mircescu G, Capsa D, Covic M *et al.* Nephrology and renal replacement therapy in Romania – transition still continues (Cinderella story revisited). *Nephrol Dial Transplant* 2004; **19**: 2971–2980.
36. Zatz R, Romao JE, Noronha IL. Nephrology in Latin America, with special emphasis on Brazil. *Kidney Int* 2003; **63**(Suppl 83): S131–S134.
37. Rutkowski B. Highlights of the epidemiology of renal replacement therapy in Central and Eastern Europe. *Nephrol Dial Transplant* 2006; **21**: 4–10.
38. Kher V. End-stage renal disease in developing countries. *Kidney Int* 2002; **62**: 350–362.
39. Sitprija V. Nephrology in South East Asia: fact and concept. *Kidney Int Suppl* 2003; **63**(Suppl 83): S128–S130.
40. Fernandez-Cean J, Gonzalez-Martinez F, Schwedt E, Mazzuchi N. Renal replacement in Latin America. *Kidney Int* 2000; **57**(Suppl 74): S55–S59.
41. Barsoum RS. End-stage renal disease in North Africa. *Kidney Int* 2003; **63**(Suppl 83): S111–S114.
42. Sakhuja V, Sud K. End-stage renal disease in India and Pakistan: burden of disease and management issues. *Kidney Int* 2003; **63**(Suppl 83): S115–S118.
43. Evans RW, Blagg CR, Bryan Jr FA. Implications for health care policy. A social and demographic profile of hemodialysis patients in the United States. *JAMA* 1981; **245**: 487–491.
44. Kasiske BL, Neylan III JF, Riggio RR *et al.* The effect of race on access and outcome in transplantation. *N Engl J Med* 1991; **324**: 302–307.
45. Held PJ, Pauly MV, Bovbjerg RR *et al.* Access to kidney transplantation. Has the United States eliminated income and racial differences? *Arch Intern Med* 1988; **148**: 2594–2600.

46. Sanfilippo FP, Vaughn WK, Peters TG *et al*. Factors affecting the waiting time of cadaveric kidney transplant candidates in the United States. *JAMA* 1992; **267**: 247–252.
47. Gaylin DS, Held PJ, Port FK *et al*. The impact of comorbid and sociodemographic factors on access to renal transplantation. *JAMA* 1993; **269**: 603–608.
48. Schieppati A, Remuzzi G. Chronic renal diseases as a public health problem: epidemiology, social, and economic implications. *Kidney Int Suppl* 2005; **68**(Suppl 98): S7–S10.
49. Kaseje DC, Juma P, Oindo M. Public health in Africa: what is new – the context, the gains, the losses, the renewed public health, and the way forward. *Kidney Int* 2005; **68**(Suppl 98): S49–S59.